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Measuring Customer Contribution to the Agile Software Development Process: A Case Study

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Measuring Customer Contribution to the Agile Software Development Process: A Case Study

by

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Report

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Dedication

I dedicate this report to colleagues, friends, and family
who have been supportive of my academic efforts.
Without their encouragement
I would have given up a long time ago.
Their unwavering faith that I can accomplish this degree
humbles me.

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Abstract

Measuring Customer Contribution to the Agile Software Development Process: A Case Study

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The University of Texas at Austin, 2010

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Agile project management and software development practices have become widely accepted in the industry and much of the currently published literature focuses on the developer's uptake of the methodology. Although it is commonly known that customers play a key role in Agile project success, the extent to which they can influence a project is not as well understood. This case study measures the contribution of customer involvement to the success of Agile projects. The study demonstrates that active customer participation is one of the top three factors for successful Agile projects. It also demonstrates that successful Agile projects have customers that are "knowledgeable, committed, collaborative, representative, and empowered". Similarly, the study shows that successful Agile projects have customers who transfer domain knowledge to project team members efficiently and effectively. The study concludes with recommendations for developers and customers that maximize an Agile project's potential for success.

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1. Introduction

1.1 AGILE FROM THE CUSTOMER'S PERSPECTIVE

Agile project management and software development practices have become widely accepted in the industry and much of the currently published literature focuses on the developer's uptake of the methodology. Although it is commonly known that customers play a key role in Agile project success, "the customer role in Agile methodologies is often perceived to be nebulous" [POPPENDIECK, 2004]. In researching this case study, it became evident that the bulk of publications from the academic world and industry have been written for two main purposes: (1) to establish Agile as a viable project management and software engineering methodology and (2) to give practical guidelines that help development teams transition from traditional incremental and iterative approaches.

Understanding the importance of the customer's role and influence on the success of Agile projects has been highlighted as part of a holistic Agile approach—an approach that centers around self-organizing teams made up of committed developers, testers. project managers, and customers. A recent focus on the customer as a vital project member is evidenced by the recent emergence of formal Agile Customer training on the market. Such training is designed to educate the customer on Agile principles and prepare them to carry out their project responsibilities.

1.2 AN AGILE OVERVIEW

In order to understand the evolution of the customer's role in Agile projects, it is important to take a look at the history of the Agile movement. "On February 11-13, 2001, at The Lodge at Snowbird ski resort in the Wasatch mountains of Utah, seventeen

people met to talk, ski, relax, and try to find common ground and of course, to eat. What emerged was the Agile Software Development Manifesto." [HIGHSMITH, 2001] Since 2001, Agile project management has seen wide adoption in the software development industry as people apply Manifesto principles of: (1) valuing individuals and their contribution to the team, (2) producing working software at the end of each iteration, (3) involving customers in key project activites, and (4) responding to frequently changing project requirements.

In a nutshell, disciplined Agile software development is, "an iterative and incremental (evolutionary) approach to software development which is performed in a highly collaborative manner by self-organizing teams within an effective governance framework with "just enough" ceremony that produces high quality software in a cost effective and timely manner which meets the changing needs of its stakeholders." [AMBLER, 2005]

The authors of the Agile Manifesto state that "we have come to value:

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan." [BECK et al., 2001]

The Manifesto authors go on to state that "while there is value in the items on the right, we value items on the left more." [BECK et al. 2001]

There are three Agile methods that are primarily used in the industry: Extreme Programming (XP), SCRUM, and the Dynamic System Development Method (DSDM). XP advocates frequent, time boxed releases with a working product at the end of the

cycle. It also promotes software engineering concepts of pair programming, test-driven development, and sustainable pace.

"SCRUM concentrates on how teams can be organized to produce software in a constantly changing environment." [CORAM & BOHNER, 2005] Product cycles, called "sprints", are short, time boxed intervals typically two to four weeks in length. Each developer's day starts with a group stand-up meeting to discuss what they plan to achieve that day and obstacles to achieving that goal. The set of requirements to be implemented are contained in a product backlog prioritized by business value.

DSDM is an extension of rapid application development (RAD) and uses an iterative and incremental approach. "One key aspect that distinguishes the DSDM approach is that it fixes time and resources first and then adjusts the amount of functionality accordingly." [CORAM et al., 2005]

All methods agree that customers play a key role in successful Agile projects and contribute to “improved product quality through better understanding of the user's needs”. [HANSEN & FAEGRI, 2006] For the purposes of this study, customers are defined as business contacts that represent the end users and perform various duties for the Agile project such as writing user stories, monitoring the progress of the project, testing the software product, maintaining contact with management, and defining acceptance criteria. They are considered part of the Agile team, and thus have responsibilities that contribute to successful project outcome.

The benefits of having engaged customers includes "improved product quality through better understanding of user needs, improved knowledge of customers' organizations, reduced risk of producing unnecessary or unacceptable functionality, improved ability to negotiate expectations among users, improved ability to resolve

conflicts regarding the design of the system, increased feeling of ownership among users, reduction in the natural resistance towards change in work practices, remedies lack of decision capability in management, improved project performance, and an increased willingness to experiment and improvise in search for solutions." [HANSEN & FAEGRI, 2006]

What seemed lacking until recently was exactly how a customer was to engage in project activities. Typically customers and developers speak different languages—customers understand the business domain and developers understand the IT domain. Because the Agile movement was founded by practitioners that spoke the developer's and tester's language, it was easier to precisely define developer's, tester's and project manager's roles. However, the widely accepted belief that an engaged customer contributes to a successful a project provides the incentive to better define the role of the customer as part of the team.

1.3 THE ORGANIZATIONAL ENVIRONMENT AND PROJECTS USED IN THIS STUDY

Data for this case study was obtained from software development projects in ExxonMobil's Upstream Research Company (URC) and Global Services Company (GSC). The majority of software project management at both ExxonMobil companies follow an incremental and iterative approach with roots that resemble a waterfall methodology. This traditional approach is embodied in two internally-developed project management methodologies tailored for two distinct environments: a research environment and a business/IT environment. The adoption of Agile principles have only begun to enter ExxonMobil's workplace in the past three or four years, mostly as a grass-roots attempt to take advantage of the perceived benefits that Agile project management offers.

This case study selected eight Agile projects which developed either engineering/scientific (ES) or business/productivity (BP) applications. Engineering/scientific applications were developed in the Upstream Research Company by engineers and geoscientists. They were typically stand-alone desktop applications that combined technology from one or more Upstream Engineering or Geoscience disciplines. Customers for engineering / scientific projects are typically highly educated researchers who provide the algorithms and scientific basis for the product.

Business/productivity applications were developed in the Global Services Company's Information Technology organization by computer scientists. They were either web applications, or client/server applications that performed data extraction, transformation, and loading. Business/productivity applications were not necessarily limited to the Upstream. Customers for business/productivity projects were typically user support staff who represented the end users.

The projects in this study used a hybrid Agile/traditional approach (primarily SCRUM), yet still operated under the guidelines of the internal project management methodologies. Most of the projects in this study had successfully applied several Agile principles, although no project followed Agile rigorously. It is estimated that less than five percent of all software development projects at ExxonMobil have adopted Agile guidelines.

The development teams for all projects were in Houston, Texas, mostly co-located or in close proximity of the customers. Some projects had customers in buildings across town or in another country.

Because this study was taken at a snapshot in time, projects were in various stages of development and release. Five of the projects dealt with legacy software when they

switched from traditional iterative/incremental project management to Agile. Some of the projects had not been released. Most of the projects were schedule driven, meaning that project management and customers held the projects to strict timelines.

1.4 CASE STUDY OBJECTIVES

The objective of this case study was to measure the contribution of customer involvement to the success of Agile projects at ExxonMobil URC and GSC. Towards that end, the study investigates three main aspects:

- The recognition that customers are a key success factor for Agile projects
- The extent that "knowledgeable, committed, collaborative, representative, and empowered" customers influenced project success
- The efficient and effective knowledge transfer that must take place between customers and the development team to ensure project success

Customer participation has always been a consideration for the success or failure of a project and the common perception is that the more customer participation, the more successful the project. How you define a successful project, Agile or not, depends upon your perspective. Project managers may view successful projects as being on time and under budget. Developers define success typically as meeting customers' expectations by implementing all requested features. Customers define success as having a user-friendly product that is fit for purpose with few released defects. Therefore, it is important to this study to use a definition of success which recognizes and honors all views (see Section 4.1, Defining Project Success).

Intuition indicates that a knowledgeable customer with a high level of commitment to the success of the project makes the project more successful. These dimensions are necessary, but not sufficient. The customer's ability to effectively

collaborate with developers, testers, and project managers sharing their experience and knowledge while objectively representing many facets of the customer's needs are also important dimensions. These factors are most effective when the customer is empowered to use those dimensions to make important project decisions.

"Knowledge is the raw material of software design teams. For complex projects, knowledge from multiple technical and functional domains is a necessity." [CURTIS, KRASNER, & ISCOE, 1988] However, acquiring, sharing, and integrating knowledge is still a challenge for projects. Successful projects are those who find ways to do this efficiently and effectively.

1.5 THE MOTIVATION FOR THIS REPORT

Literature searches clearly indicate that more research is needed to define the impact of the customer's involvement on Agile teams. The “customer gap” or how to best use a customer’s talent to produce successful software products is the focus of this study. The continuation of the report first gives the data collection and analysis methods used in this study (Section 2). The report then presents project demographics and Agile parameters (Section 3). Further on the results and analysis is presented for the three main aspects (Sections 4 through 6). Finally, the report concludes with recommendations for developers and customers that maximize an Agile project's potential for success (Section 7) and areas of future study (Section 8).

2. Data Collection and Analysis

2.1 DEFINING RELEVANT AGILE MEASURES

The Goal-Question-Metric (GQM) approach [KRASNER, 2010] was used to explore the three main aspects of study. The rationale for choosing this approach was to clearly define the exact metrics and measures relevant to the study.

The goals and relevant questions were as follows:

- Goal #1: prove that active customer participation will be one of the top three factors for successful Agile projects.
    - How many projects have applied Agile principles and how successful have they been?
    - How do project managers, developers, testers, and customers define success?
- Goal #2: prove that effective customers are knowledgeable, committed, collaborative, representative, and empowered.
    - What is the role of the customer in Agile projects?
    - Can we correlate the success of a project to the level of customer knowledge, commitment, collaboration, representation, and empowerment?
- Goal #3: prove that successful Agile projects have customers who transfer domain knowledge to development team members efficiently and effectively.
    - What Agile project activities require efficient and effective knowledge transfer?

- What are efficient ways to transfer knowledge?
- What are effective ways to transfer knowledge?
- Is there a correlation between the efficiency and effectiveness of knowledge transfer from the customer to the development team and a successful project?

2.2 DATA COLLECTION METHODS

The author used interviews, online surveys, and project documents to collect measures for this study. The strategy was to first conduct the development team interview to get basic project information. It was important to conduct development team interviews first so that there was an agreement on the time frame of interest, to request customer names, and to obtain a listing of the product's technical domains.

The second step was to schedule and conduct the customer interviews. Both the developer/tester and the customer interviews asked questions that were primarily factual, such as the architecture of the software (for developers / testers) and the number of face-to-face meetings with the development team (for customers).

Following the developer/tester and customer interviews, participants were asked to complete an online survey (developers/testers and customers answered different surveys). Survey questions focused primarily on matters of opinion, such as whether the customer thought the project management methodology helped or hindered project success. Survey results were anonymous and the only identifying feature was the project name.

Of the eight projects, 16 developers/testers and 14 customers were interviewed (a total of 30 participants). 15 developers/testers and 12 customers took the follow up survey (90% of the total number interviewed).

Tools used in this case study were SurveyMonkey (www.surveymonkey.com) for the online survey, Microsoft's Team Foundation Server© for determining the number of user stories and defect counts, Visual Studio© for determining lines of code (LOC), and Excel© to compile and analyze the results.

Nomenclature for this report is as follows:

- Engineering/scientific projects are listed as ES# and business/productivity projects are listed as BP#. The number (#) after the abbreviation does not imply any particular order.
- Questions and answer choices used on developer/tester surveys are listed as (DS#), where the # refers to the question number. Similarly, questions to developer/tester interviews are listed as (DI#). See Appendix A for a complete list of developer/tester survey and interview questions and answer choices.
- Questions on customer surveys are listed as (CS#) and questions on customer interviews are listed as (CI#). See Appendix B for a complete listing of customer survey and interview questions and answer choices.

Results in this study are presented in two main groupings: four engineering/scientific software projects were grouped and four business/productivity software projects were grouped for comparison. This was done because development teams from these two groups are fundamentally different. As mentioned previously, "URC has a dedicated team of engineers and scientists skilled in technical software development. This team, together with the computer science experts from (GSC) is organized to enable the delivery of technology to the field." [MULKAY & BAKER, 2009] For more information, refer to Section 1.3.

2.3 DATA ANALYSIS METHODS

The data analysis consisted of grouping the questions and combining the measures for each of the three key aspects according to stated definitions. Once the combinations were complete, it was then possible to analyze the data or ask interesting questions to prove a point.

An important step essential for combining various questions/answers prior to analysis was to transform interview and survey questions/answers to a common scale. Note that it was possible to answer questions in one of three ways:

- With ordinal answers which included a relative order of magnitude such as daily, 2-3 times per week, once a week, once a month, or longer than once per month.
- With nominal answers with a binary decision which was either yes or no.
- With interval answers which lent themselves to a five point Likert scale — Agree Strongly (5 points), Agree Somewhat (4 points), Neither Agree nor Disagree (3 points), Disagree Somewhat (2 points), Disagree Strongly (1 point).

The challenge was to assign a common 5-point scale to ordinal and nominal answers. Based on research and experience, the ordinal and nominal answers were assigned a 5-point scale which allowed the data to be combined (see Appendix C).

2.4 ASSUMPTIONS

When assigning a point scale to nominal and ordinal questions, care was taken to preserve the relative ranking (if dealing with ordinal answers) or honor the software engineering research (if dealing with nominal answers) without overly penalizing a project. For example, for the ordinal question, “How many years have you worked in

the oil and gas industry?" participants received 2 points for an answer of "Less than 3 years" and 5 points for an answer of "More than 10 years", which preserved the relative order.

Nominal questions, however, were a little more challenging. For example, for the question, "In your opinion, did procedures help project progress or hinder it?" participants received 5 points for an answer of "Helped project progress", 1 point for "Hindered project progress", and 3 points for "No opinion". The rationale for assigning points was that procedures that help project progress enhance the efficiency of knowledge transfer should get more points than those that hinder project progress. What was more difficult was how to assign points to the answer of "No opinion". The final decision was to treat it as a neutral answer, much like the neutral answer on a Likert scale – "Neither agree nor disagree" and give the answer 3 points.

Because of the large number of questions used in surveys and interviews, the assumption of how to assign point values should not bias the overall results if applied fairly. For a detailed analysis of the transformation for each ordinal or nominal question/answer including the assignment of points, see Appendix C.

2.5 LIMITATIONS

The interviews and surveys were not exhaustive in that not all developers or testers on the development team were interviewed. However, the author tried to select representative developers and testers as they were available. Because this case study focused on Agile project management practices, most trained, certified ScrumMasters were included in the interviews. This was positive in that they were knowledgeable about Scrum practices. However, their enthusiasm for "telling their Agile story" sometimes made it difficult to discern whether an Agile practice was in place and

beneficial or just wishful thinking. Careful questioning and clarification helped overcome this bias.

Similarly, only two or three customers were chosen to represent all customers and ultimately the end users. Since the development team suggested customer contacts, the author was less able to screen candidates. This is not thought to be a problem, as carefully worded questions and clarification in the interview process seemed to help the consistency of answers.

For the survey, the goal was to get at least two customers and two developers to respond. In some cases only one developer or customer responded. By accepting this situation, there was a risk that the developer/tester or customer may not be truly representative. Therefore, where possible the author combined small, related projects to overcome this bias. Where combining projects did not make sense, the author included the single response project anyway. Note that projects ES3, ES4, BP2 and BP4 had only one customer response to both the interview and survey questions. Also, BP2 had one developer response to both the interview and the survey.

3. Project Demographics and Agile Parameters

3.1 PROJECT DEMOGRAPHICS

Project demographics are shown in Table 3.1.1. ES refers to engineering/scientific applications and BP refers to business/productivity applications. The average number of end users for the six applications that have been released is approximately 130. The average development team size contains approximately 6 developers/testers.

App	Number of End Users (1)	Number of Developers and Testers (2)	New vs. Legacy Code (3)
ES1	N/A	12	New
ES2	400+	12	Legacy
ES3	80	3	Legacy
ES4	N/A	4	New
BP1	10	5	New
BP2	5	5	Legacy
BP3	50	2	Legacy
BP4	250	8	Legacy

Table 3.1.1: Project Demographics

(1) N/A means this product has not been released.

(2) Some of the developers and testers may have worked part time on the project.

(3) Legacy code means parts of the application were re-written from previously existing code.

Development teams contained a range of novice to experienced developers and testers. The experience ranges were evenly divided: 27% of the total developers/testers

interviewed had less than 3 years experience, 20% had 3 to 5 years experience, 26% had 6 to 10 years experience, and 27% had over 10 years development experience.

For some projects, the project manager (also called project or team lead) was also a developer. Most of the projects did not have a full time project manager. This was because the development team was too small to warrant a full time project manager, management chose to staff the development team with a part time project manager, or the business supplied a person to assume project management responsibilities. Typically the project manager handled the rigors of managing to the internally-developed (incremental and iterative) project management methodologies and shielded developers, testers, and customers from those duties. It is interesting to note that developers and testers recognized the contribution of the project manager to the success of the project, primarily for allowing them the flexibility of running the project in an Agile fashion.

3.2 PRODUCT SIZE

Product size measurements are shown in Table 3.2.1. Note that all of the engineering/scientific applications were stand alone, Windows® desktop applications. Business/productivity applications were a mixture of web applications and client/server applications.

The number of user stories is approximate as the author accepted epics, user stories, or traditional requirements (business, user, functional, non-functional) as a measure of size. Most projects wrote user stories vs. traditional requirements (see Table 3.3.1); however, this was not exclusively done.

Project Name	LOC (1)	Architecture (2)	Language	No. User Stories
ES1	100K - 500K	SA Desktop	C#, .NET	>300
ES2	100K - 500K	SA Desktop	C++, C#, .NET	<100
ES3	>500K	SA Desktop	C#, .NET	>300
ES4	100K - 500K	SA Desktop	C++, C#, .NET	100 - 300
BP1	<100K	Web app	VB.NET	100 - 300
BP2	>500K	Web app	VB.NET	100 - 300
BP3	>500K	C/S	C#, .NET	100 - 300
BP4	100K - 500K	C/S	C#, .NET	<100

Table 3.2.1: Product Size

(1) LOC = lines of code. These numbers were obtained from Visual Studio©.
(2) SA Desktop means Windows® stand alone desktop. C/S means client/server.

3.3 AGILE CHARACTERISTICS

The extent to which projects followed Agile principles is shown in Table 3.3.1. Values in the table should be read (for example) as 50% of the eight Agile projects in this study held daily stand up meetings.

Agile characteristics were collected in developer/tester interviews so that clarifications could be made. If the project performed a specific Agile practice a majority of the time during the period of interest, they were counted in Table 3.3.1. If they did not attempt the practice, or attempted and abandoned it (i.e. practiced it less than 50% of the time), they would not be shown in Table 3.3.1.

Agile Characteristic	% Project Implementation
Holding daily stand up meetings	50%
Writing user stories	87.5%
Maintaining and "grooming" the product backlog	87.5%
Prioritizing the product backlog	87.5%
Using planning poker for project estimating	25%
Adhering to short (1 month or less) iterations	50%
Performing customer reviews at the end of iterations	50%
Calculating and using velocity (work in an iteration)	12.5%
Calculating and displaying burn down charts	37.5%
Performing release planning	50%
Using test first or test driven development	25%
Using pair programming	50%
Creating and executing automated tests	50%
Performing continuous build and integration	62.5%
Performing retrospectives at the end of iterations	12.5%

Table 3.3.1: Agile Characteristics

3.4 AGILE TRIGGERS

Because some Agile projects evolved from traditional, iterative and incremental project planning and control projects, it was important to clearly define the time span for the interviews and surveys. Early in the developer/tester interviews, the author asked the

development team to pinpoint the calendar date when the project started practicing Agile principles. Responses to interview and survey questions were limited to that time span, ensuring that no legacy answers were mixed in the results.

When asked, "What triggered your switch or use of Agile?", the following general responses were given:

- Developers used Agile on a previous project or had attended an Agile Conference and saw merit in the approach. (2 out of 8 projects)
- Customers and customer management lost confidence in previous (legacy) attempts to produce quality software within a set period of time. Agile was perceived of a way to deliver value to the customer and build confidence. (1 out of 8 projects)
- The project changed quickly (loss or addition of resources, scope fluctuations, hard deadlines) and Agile was seen as a way to address these changes. (5 out of 8 projects)

4. Successful Agile Projects

4.1 DEFINING PROJECT SUCCESS

Before determining if customer participation is a top factor for project success, it is important to define what makes a project successful. "Delivering a system that satisfies customer requirements on time and within budget with few defects is the ultimate goal of any software development activity." [GRISHAM & PERRY, 2005] In addition, overall customer satisfaction is an important aspect of project success.

For the purposes of this study, project success will be defined using a combination of two groups of questions:

- Success factors pertaining to project execution
- Success factors pertaining to project outcome

After establishing this definition, the study then determines if customer participation is one of the top three reasons for project success

Successful project execution combined questions/responses focused on operational issues that included the questions below. Note that specific questions are listed as developer interview (DI#), developer survey (DS#), customer interview (CI#), or customer survey (CS#) where # is the question number (see Appendix A for specific developer questions and responses and Appendix B for specific customer questions and responses).

- The percent of customer involvement (CI4)
- Whether customers had their management's support to participate on the project (CS13)
- The development team's location with respect to their customers (DI11)

- Customer's and developer's / tester's statement of whether:
    - Team members exhibited a collaborative attitude (DS10 and CS17)
    - Team members showed a sense of responsibility for completing his/her tasks (DS10 and CS17)
    - Team members were willing to learn and try new things (DS10 and CS17)
- The development team's level of experience, measured as working on a similar project in the past (DS3) and years experience (DS2)
- Appropriate software development tools were in place (DI14)
- A project management methodology was in place (DI22) and allowed the development team the flexibility to adopt Agile principles (DI23)

Successful project outcome combined questions / responses on various perspectives of success from the developer's, tester's, project manager's, and customer's perspective and included:

- Whether the project was under, on, or over budget (DI24)
- Whether the project was ahead, on, or behind schedule (DI24)
- Whether the project implemented all project features (DI24)
- Whether the project met customer expectations (DS13)
- Whether the project delivered critical or high severity defects to the end user (DI24)
- Whether the developer/tester (DS11) and most importantly the customer (CS18) thought the project was successful

Based on project documents and interview and survey responses, project execution (PES) and project outcome (POS) scores were computed for each project.

Responses to questions were combined based on the 5-point answer scale previously mentioned (also see Appendix C).

The Total Success Factor (TSF) is the combination of the PES and the POS score. The TSF is important as it will use it as a benchmark to gage the customer's contribution to the success of the project. Table 4.1.1 shows the PES, POS, and TSF for all projects, grouped by engineering/scientific or business/productivity and ranked from most successful to least successful.

To aid in interpreting Table 4.1.1, it is important to note that the lowest PES score possible was 22, and the highest PES score possible was 66. Similarly, the range of POS scores went from a minimum of 13 to a maximum of 38. This meant the range of scores for the Total Success Factor went from 35 to 104.

Project Name	**Project Execution Score (PES)**	**Project Outcome Score (POS)**	**Total Success Factor (TSF)**
ES1	63.77	29.50	95.27
ES2	59.60	30.00	89.60
ES3	63.42	26.00	89.42
ES4	62.00	23.50	87.50
BP4	59.00	28.00	87.00
BP1	60.80	24.00	84.80
BP3	56.17	25.50	81.67
BP2	54.50	25.00	79.50

Table 4.1.1: Project Execution Score, Project Outcome Score, and Total Success Factor

4.2 DISCUSSION

Project execution survey and interview questions focused on the development team and were chosen based on operational factors that provided the opportunity for a successful project. These factors included:

- Access to active and experienced customers
- The willingness and ability to try new things
- Experience and a responsibility for completing the job
- The existence of a project planning and control methodology
- Appropriate tools

Project outcome survey and interview questions were chosen based on various perspectives of success:

- Project manager's perception of on time and budget
- Developer's perceptions that software should include all features and meet customer's expectations
- Tester's perception that testing should prevent critical and high severity defects from being released

The most important factor, however, is whether the developers/testers, and customers thought their project was successful. The points assigned to developer's/tester's statement of success (4 points) vs. the customer's statement of success (5 points) favored the customer's opionion.

Based on survey results, 7 of the 8 projects cited access to active and knowledgeable customers as one of their top three factors that contributed to success. Table 4.1.1 shows that for the engineering/scientific grouping, there was clearly one project that was clearly more successful than the middle two projects, followed by the

least successful project. For business/productivity, the top two projects are clearly more successful than the bottom two projects.

When their relative success ranking was correlated with responses to the question, "select the top three factors that you think contributed to the project success", it is interesting to note that all engineering/scientific developers/testers listed active and knowledgeable customers as their number one factor for success. Business/productivity developers/testers were more likely to list competent and dedicated developers and testers as their number one factor for success.

The question, "is your project successful?" was posed to developers/testers and customers and 3 of the 8 projects unanimously agreed that their project was successful. Five of the 8 projects answered "maybe, with qualifications". However, a deeper analysis revealed that the most successful projects in both the ES and BP groupings were ones that customers said were successful, and they attributed success primarily to competent and dedicated developers and testers on the project.

An interesting result emerged in that some of the more successful Agile projects were not necessarily on time or budget—the classic definition of a successful project. However, the perception from the customer that the product met their expectations, was fit for purpose, and that they were given the opportunity to influence the software development effort seemed to outweigh those facts.

In summary, successful projects cite active and knowledgeable customers as one of their top three success factors. And, now that there is an established definition of success, we can use this definition to further understand the role of the customer and the impact they have on project success.

5. Characteristics of Agile Customers

5.1 Defining the "perfect" customer

Boehm [TURNER & BOEHM, 2003] indicates that "while methodologies, management techniques, and technical approaches are valuable, the most critical success factors are much more likely to be in the realm of people factors." In earlier work, he stated that "unless customers are knowledgeable, committed, collaborative, representative, and empowered, the developed products generally do not transition into use successfully, even though they may satisfy the customer." [BOEHM, 2002] This part of the case study focuses solely on the customer to determine the extent that those five dimensions (knowledgeable, commitment, collaboration, representation, and empowerment) influenced project success.

"Knowledge is information combined with experience, context, interpretation, reflection, intuition, and creativity." [KARLSEN & GOTTSCHALK, 2004] A knowledgeable customer has depth of expertise in one or more software technical domain areas. Curtis, et.al. states that "for complex projects, knowledge from multiple technical and functional domains is a necessity." [CURTIS et al., 1988]

The following interview and survey results were combined to define the level of customer knowledge:

- Number of years in the oil and gas industry (CS1)
- Level of education achieved (CS2)
- Level of expertise (basic, competent, expert, or advanced expert) in the technical and functional domains (CS6)

- Prior experience with participating on software development projects (CS3)

A committed customer is a person who delicates their time to an Agile project. But more than that, a committed customer proactively transferred this knowledge to the development team, rather than reactively, or only as requested. These interview and survey results were combined to determine the level of customer commitment:

- Percent customer involvement (CI4)
- The customer's propensity to proactively mentor or train developers/testers (CS7)

A collaborative customer works jointly with the development team in a cooperative fashion rather than independently. These interview and survey results were combined to determine the level of customer collaboration:

- The percentage of time the customer worked jointly with the development team (CI5)
- The number of informal, face-to-face meetings with the development team (CI7)

A representative customer refers to the breadth of expertise of the customer. It gives an indication of how well customers represent all aspects of the software problem domain. These interview and survey results were combined to determine the level of customer representation:

- Whether all technical domains were represented by customers (CS5)
- Whether a customer represented more than one technical domain (overlapping expertise) (CS5)

An empowered customer has the power and authority to independently make project decisions. Project decisions may include setting priority or approving work items. Responses for the level of empowerment were based on Franklin Covey's *Seven Levels of Initiative or Self Empowerment.* [COVEY, 2004] These interview and survey results were combined to determine the level of customer empowerment:

- The total number of decisions made per week (CS15)
- The level of empowerment as measured by Covey's empowerment scale (CS16)

A numerical value for all five customer dimensions was calculated and combined into a total score for each project (called the Customer Dimension Total). This combined score was then compared with project success rankings and analyzed for trends as described below.

5.2 THE CUSTOMER AND AGILE SUCCESS

Table 5.2.1 shows the individual customer dimensions for each project. The Customer Dimension Total (shown in Table 5.2.2) is the sum of all dimensions for each project. To aid in interpreting Table 5.2.1, note that the ranges for each dimension are as follows:

- Knowledgeable scores ranged from a minimum of 10 to a maximum of 20
- Committed scores ranged from a minimum of 2 to a maximum of 10
- Collaborative scores ranged from a minimum of 3 to a maximum of 10
- Representative scores ranged from a minimum of 6 to a maximum of 10
- Empowered scores ranged from a minimum of 3 to a maximum of 10

This meant that the Customer Dimension Total ranged from a minimum of 24 to a maximum of 60.

Project Name	Knowledgeable	Committed	Collaborative	Representative	Empowered
ES1	16.00	10.00	9.00	6.25	9.00
ES2	15.67	8.00	10.00	6.00	7.00
ES3	14.75	6.00	8.00	5.75	8.00
ES4	14.50	6.00	8.00	6.50	8.00
BP4	15.50	6.00	8.00	5.75	6.00
BP1	14.67	5.33	6.67	6.25	7.00
BP3	13.50	8.00	6.00	6.50	8.00
BP2	12.33	6.00	7.00	6.00	6.00

Table 5.2.1: ES and BP Customer Dimensions for Each Project

Table 5.2.2 shows the comparison of the Customer Dimension Total and the Total Success Factor. Note that the projects are sorted according to their Total Success Factor.

Project Name	Customer Dimension Total	Total Success Factor
ES1	50.25	95.27
ES2	46.67	89.60
ES3	42.50	89.42
ES4	43.00	87.50
BP4	41.25	87.00
BP1	39.92	84.80
BP3	42.00	81.67
BP2	37.33	79.50

Table 5.2.2: Customer Dimension Total and Total Success Factors

5.3 DISCUSSION

For engineering/scientific projects, the Customer Dimension Totals tracked very closely with the Total Success Factors confirming that knowledgeable, committed, collaborative, representative, and empowered customers are strongly related to project success. There was a slight discrepancy for projects ES3 and ES4, but the difference of 0.5 is considered to be negligible. The strongest correlation for engineering/scientific projects is most notable in the committed and knowledgeable dimensions. This conclusion is also supported by linear regression methods (correlation coefficients of 0.91 and 0.83 respectively.)

Business/productivity projects demonstrated an interesting phenomenon in that the third place project success-wise (BP3) had a higher Customer Dimension Total than the other three projects (BP4, BP1, and BP2 respectively). The difference in the Customer Dimension Total between the top three projects is 2.08 and shows a tighter clumping of points than the Total Success Factor. The anomaly for BP3 can be explained in part by the fact that it was one of the projects with fewer responses. Because these few responses were strongly committed, representative, and empowered, it tended to produce higher results. The least successful project (BP2) was consistently distant for both totals. The strongest correlation for business/productivity projects is similar to the engineering/scientific projects in that it is most notable in the committed and knowledgeable dimensions. This conclusion is also supported by linear regression methods with similar correlation coefficients.

A deeper analysis was made to determine the dimension that dominated the Customer Dimension Total. For each project in all dimensions, an average score was calculated per question. For example, if four questions were combined to produce a

Customer Dimension Total of 16.00 for the knowledgeable dimension of project ES1, the average score was 16.00 / 4 = 4.00. These averages were then averaged to determine the total average for that dimension (see Table 5.3.1).

Knowledgeable	Committed	Collaborative	Representative	Empowered
3.65	3.48	3.92	3.06	3.69

Table 5.3.1: Total Average Score for each Dimension

Table 5.3.1 suggests that the factor that most influences customer dimensions is collaboration, followed by empowered, knowledgeable, committed, and representative.

If the averages are broken out by engineering/scientific or business/productivity projects, an interesting trend appears as shown in Table 5.4.1. The results suggest that the engineering/scientific projects are more strongly committed, collaborative, and empowered than business/productivity projects as shown by the large differences between the results in these dimensions.

Group	Knowledgeable	Committed	Collaborative	Representative	Empowered
ES	3.81	3.75	4.38	3.06	4.00
BP	3.50	3.17	3.46	3.06	3.38

Table 5.3.2: Total Average Score for each Dimension by Grouping

This difference between engineering/scientific projects and business/productivity projects is not surprising, given the characteristics of the two project groupings.

- Engineering/scientific customers exhibited a higher level of involvement than business/productivity projects, which resulted in a higher commitment level.

- Engineering/scientific projects tended to be more co-located than business/productivity projects, suggesting a tighter collaboration.
- Engineering/scientific project customers tended to make a number of independent decisions (i.e. showed a higher sense of empowerment) vs. business/productivity projects whose customers were more likely to make recommendations or ask for additional instructions before making a decision.

In summary, there is a strong correlation between project success and knowledgeable, committed, collaborative, representative, and empowered customers. Engineering/scientific customers are highly knowledgeable, committed, and empowered. Business/productivity customers are knowledgeable and equally representative, but less committed.

6. Knowledge Transfer in Agile Projects

6.1 DEFINING KNOWLEDGE TRANSFER

The goal of any software development project is to staff it with the required expertise needed to successfully develop and test the product. However, because of the complexity of software, and the integration of multiple technical domains, skill gaps exist. These gaps must be bridged with:

- "Relevant documentation
- Formal training
- Results of trial and error behavior
- Other team members" [WALZ, ELAM, & CURTIS, 1993]
- Specialized research and expertise outside the team (in the case of engineering/scientific software)

A successful Agile project will depend upon how efficiently and effectively a customer transfers technical and business knowledge to the developers and testers. Efficient knowledge transfer is defined as exchanging information "without wasting time or effort or expense". [WordNet, 2010] Similarly, effective knowledge transfer is defined as knowledge that is "properly transmitted and used". [LAFRAMBOISE, CROTEAU, BEAUDRY, & MANOVAS, 2007]

The benefits of effective and efficient knowledge transfer includes "reduced errors, less work, fewer questions, better decisions, better customer relations, improved service, and increased profitability." [KARLSEN, et al., 2004]

Agile customers have multiple opportunities to transfer knowledge to the development team. At the beginning of the project, requirements elicitation (writing

user stories) is a key customer/developer knowledge transfer opportunity. Other opportunities include:

- Prioritizing user stories
- Reviewing the product and giving feedback at the end of each iteration
- Defining and executing user acceptance tests
- Detecting and reporting software defects

Efficient knowledge transfer requires basic information technology (email, intranet, databases, networks, etc.) to be in place. It is enhanced by the presence of co-located teams who work within a common set of systems and procedures. It is also enhanced by an organizational culture that provides dedicated and knowledgeable resources to software development projects. Case studies show that "assigning one or two individuals with deep application domain and technical knowledge to a design project can significantly reduce the learning time involved." [WALZ et al., 1993]

Effective knowledge transfer requires multiple information technology solutions (i.e. choices) for communicating appropriately. Systems and procedures promote effective knowledge transfer if they enable storing and using project experience. Scott Ambler [AMBLER, 2001] “describes various modes of communication that people may choose to apply when working together”. Figure 6.1.1, from the book *SDLC 3.0* “shows a graph comparing the effectiveness of these modes of communication with the richness of the communication channel employed." [AMBLER, 2001]

The figure indicates that using paper-based documentation for knowledge transfer is not as effective as email, phone, or face-to-face conversations (in order of increasing effectiveness). It also suggests that the richness of the communication channel is at its

maximum effectiveness when face-to-face conversation or face-to-face whiteboard sessions are used.

In some cases, a factor can directly relate to knowledge transfer efficiency and effectiveness. For example, a development team that is co-located with their customers had the opportunity to meet for face-to-face conversations more frequently than teams that are dispersed in different office locations.

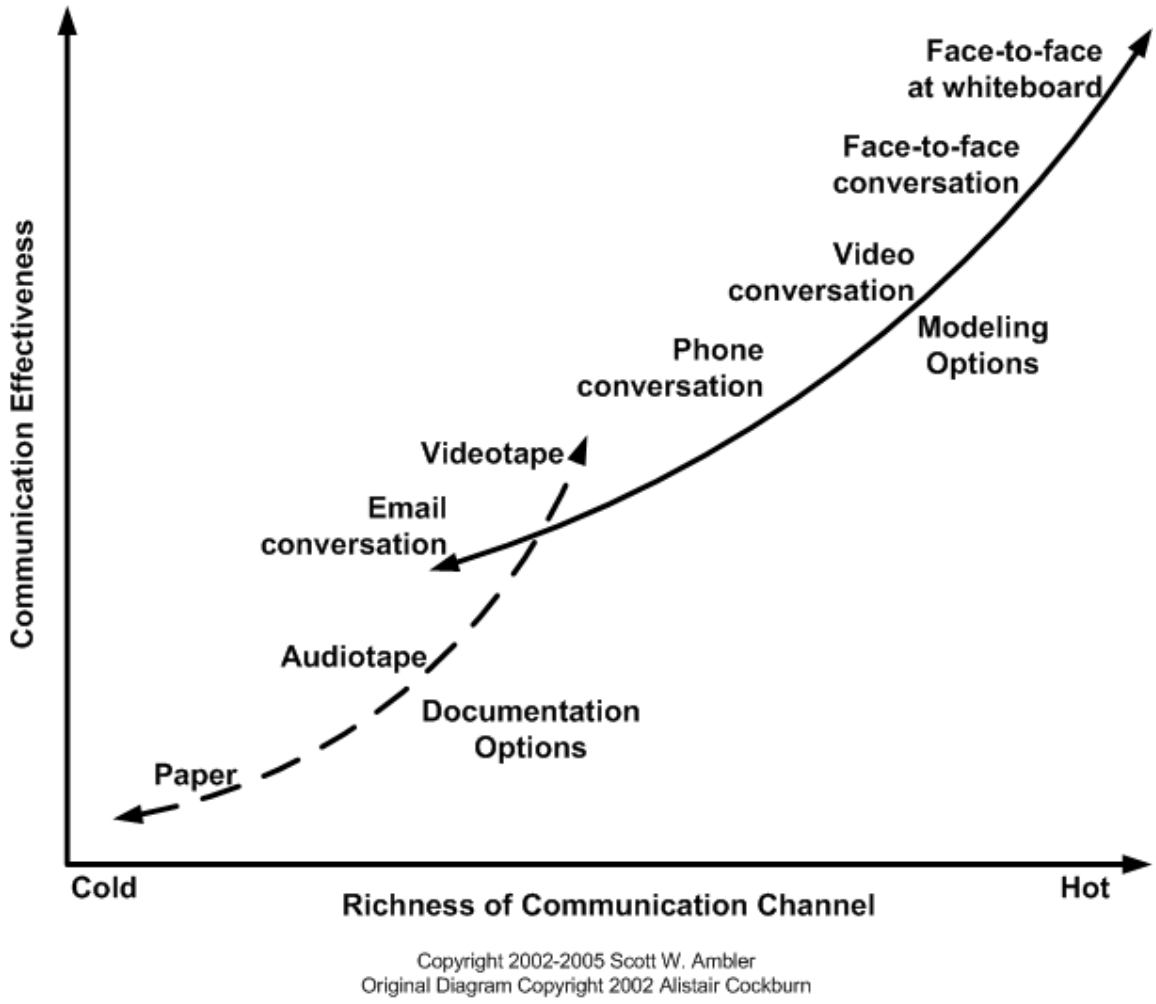

Figure 6.1.1: Communication Effectiveness from the book *SDLC 3.0*

6.2 MEASURING KNOWLEDGE TRANSFER

Three sets of factors were reviewed to determine the efficiency and effectiveness of knowledge transfer for an Agile project: general factors, efficiency only factors, and effectiveness only factors. Note that general factors could influence both efficiency and effectiveness.

These interview and survey results were combined to define general characteristics pertinent to both efficient and effective knowledge transfer:

- The development team's location with respect to the customers (DI11)
- The existence of common procedures (CS10)
- The customer's propensity to proactively mentor or train developers / testers (CS7)

These interview and survey results were combined to define the efficiency only factor:

- The availability of tools such as email, networks, databases, Intra / Internet (CS8)
- Procedures that facilitated project progress vs. hindered it (CS11)

These interview and survey results were combined to define the effectiveness only factor:

- The customer's preference for communicating with the development team (in person, by phone, by email, or by instant message) (CS9)
- Procedures that enhanced communication vs. confused it (CS12)

After calculating the general, efficiency only, and effectiveness only factors for each project, two total factors were produced: Total Efficiency (adding general factor to efficiency only) and Total Effectiveness (found by adding general factor to

effectiveness). Again, these factors were compared with the Total Success Factor for each project as shown in Table 6.2.1.

Project Name	General Character.	Efficiency Only	Effectiveness Only	Total Efficiency	Total Effectiveness	Total Success Factor
ES1	11.60	10.00	8.00	21.60	19.60	95.27
ES2	9.60	9.50	10.00	19.10	19.60	89.60
ES3	6.75	10.00	10.00	16.75	16.75	89.42
ES4	9.00	10.00	10.00	19.00	19.00	87.50
BP4	8.00	5.00	8.00	13.00	16.00	87.00
BP1	10.47	7.00	8.67	17.47	19.13	84.80
BP3	7.17	9.00	10.00	16.17	17.17	81.67
BP2	7.00	7.00	8.00	14.00	15.00	79.50

Table 6.2.1: Efficiency and Effectiveness for Each Project

6.3 DISCUSSION

For engineering/scientific projects, Total Efficiency compared favorably with the Total Success Factor with the exception of the least successful project (ES4). Again, the anomaly for ES4 can be explained in part by the fact that it was one of the projects with fewer responses. Because this is a small, co-located team, it had high efficiency results.

For business/productivity projects, Total Efficiency compared well with the Total Success Factor with the exception of the most successful project (BP4). The most successful business/productivity project scored the lowest in Total Efficiency because they felt that the lack of common procedures hindered project progress.

For engineering/scientific projects, Total Effectiveness showed an interesting clumping of projects with the exception of the third most successful project (ES3). This project scored low in efficiency because of two reasons: lack of procedures and the customer's reactionary propensity to engage the development team only when requested.

For business/productivity projects, Total Effectiveness tracked well with the Total Success Factor with the exception of (again) the most successful project (BP4). The most successful business/productivity project low in Total Effectiveness because they felt that the lack of common procedures confused project communication.

Looking at the project groupings, and comparing each factor we see some interesting trends as shown in Table 6.3.1.

Group	General Character.	Efficiency Only	Effectiveness Only	Total Efficiency	Total Effectiveness
ES	9.24	9.88	9.50	19.11	18.74
BP	8.16	7.00	8.67	15.16	16.83

Table 6.3.1: Total Average Efficiency and Effectiveness by Grouping

Table 6.3.1 shows a large difference in Total Efficiency and Total Effectiveness between engineering/scientific and business/productivity projects. This can be attributed to two main factors:

- Engineering/scientific projects tended to be more co-located than business/productivity projects, suggesting the potential for greater efficiency and effectiveness.
- Business/productivity projects believed that their procedures confused project communication and hindered project progress.

7. Conclusions and Recommendations

7.1 AGILE DEVELOPERS / TESTERS AND SUCCESS

It was really no surprise that development teams cited active and knowledgeable customers as one of their top three factors for success. The idea that customers can positively impact projects has been known and proven in the software development industry for decades. What makes this study interesting, however, is that given the case study results, and specifically for the eight projects involved, the fact that they have been as successful as they have been. Taken positively, this suggests that there is room to make Agile projects at ExxonMobil even more successful in the future.

Agile training played an important role in helping projects get started. For example, 75% of the development teams (100% of engineering/scientific and 50% of business/productivity) had taken formal Agile training or attended conferences that offered extended Agile tutorials. A small number of development teams had Certified ScrumMasters, although this measure was not formally recorded. Compare this to customers where only 37.5% (50% for engineering/scientific and 25% for business/productivity) had even heard of Agile software project management practices. Of the projects who had Agile customer training, only one customer had taken formal Agile developer training, the other two had been briefed by the development team. Not surprising, projects with some level of Agile training were more successful than those who had not taken training.

The developer/tester survey asked participants to compare their level of Agile expertise (either novice, competent, or expert) at the time they switched to Agile vs. the present time. Table 7.1.1 shows that some Agile developers/testers improved their Agile

competency through job experience. The column titled "Increased Expert Competency" is the average percentage increase of developers/testers from "competent" to "expert" during the period of interest (the time the project transitioned to Agile to interview time or project close out whichever came first). For example, ES1 had an average of 3.33% experts at the time of the transition and 47.33% experts now. Their increase in expert competency is 47.33% - 3.33% or 44%. Similar rationale for the column titled "Increased Competent Competency".

Project Name	Increased Expert Competency	Increased Competent Competency	Total Success Factor
ES1	44%	9.33%	95.27
ES2	13.33%	43.33%	89.60
ES3	5%	30%	89.42
ES4	0%	50%	87.50
BP4	25%	0%	87.00
BP1	0%	35%	84.80
BP3	0%	0%	81.67
BP2	0%	0%	79.50

Table 7.1.1: Total Success Factors and On the Job Training

What is interesting about this table is that the results indicate there is little correlation between the increase in competency and the length of time that the project used Agile practices. It does more closely follow the training trend which suggests that formal training for Agile team members improved their on-the-job competency.

Because projects transitioned to Agile as a grass roots movement, it is also not surprising that not all projects rigorously followed Agile practices. As one developer

aptly stated, "we prefer to be Agile about Agile". Whereas this may have made it easier to adopt and sustain Agile practices, it also potentially resulted a loss of benefits from not consistently applying it as well.

For example, only 4 of the 8 projects practiced more than 50% of Agile practices (3 of 4 engineering/scientific projects and 1 of 4 business productivity projects). When compared to the Total Success Factor (see Table 7.1.2) it is evident that the most successful engineering/scientific projects benefitted from applying and sustaining Agile practices.

Project Name	% Apply Agile Principles	Total Success Factor
ES1	87%	95.27
ES2	67%	89.60
ES3	53%	89.42
ES4	20%	87.50
BP4	33%	87.00
BP1	47%	84.80
BP3	33%	81.67
BP2	53%	79.50

Table 7.1.2: Total Success Factors and Applying Agile Principles

It is also the author's belief that consistent application of Agile practices was one of the factors that showed engineering/scientific projects more favorable than business/productivity projects in many categories (e.g. higher overall Total Success Factor).

7.2 AGILE CUSTOMERS AND SUCCESS

Focusing on the customer, project success is dependent upon having knowledgeable, committed, collaborative, representative, and empowered customers. The dimensions that contributed most to that success were knowledgeable, collaborative, and empowered customers. But let's look a little closer at the other two dimensions that did not contribute as much: committed and representative. Only 3 of 8 projects had customers who spent more than 50% of their time with the development team; and, it is interesting to note that all three were engineering/scientific projects. Only 2 of 8 projects had customers who represented end users in more than one technical domain. Again, these two projects were engineering/scientific projects.

The results also demonstrated a successful Agile project has customers who efficiently and effectively transfer technical and business knowledge to the developers and testers. What is interesting about this result is the influence that a common set of procedures have on knowledge transfer. Half of the projects indicated that procedures enhanced (vs. confused) communication, a key aspect of efficient knowledge transfer. Similarly, half of the projects indicated that procedures facilitated project progress (vs. hindered it), a key aspect of effective knowledge transfer. These results are directly related to the use and application of internally developed project management methodologies.

"An effective team member on an [Agile] project must be someone who enjoys collaborative efforts, and who is prepared to be available to team members to answer questions, to help with problem solving, to be open-minded, honest, objectively critical, and respectful." [FARELL, NARANG, KAPITAN, & WEBBER, 2002]

7.3 RECOMMENDATIONS

It seems obvious that an investment in Agile developer/tester and customer training would be beneficial. Formal Agile developer/tester training is readily available in the industry for a reasonable price. ExxonMobil is beginning to introduce a few Agile courses taught by leading industry experts through the URC Upstream Technical Training group. The author recommends that projects who wish to transition to Agile practices send both developers/testers and customers to formal training. In addition, Agile customer training is now available in the industry and is specifically focused on the customer's role. Each role should receive the training specifically designed for that role.

If the first recommendation is followed, it should result in a more uniform application of Agile principles and practices. The discipline to apply Agile principles and practices more uniformly (not necessarily religiously) should result in an improved overall Total Success Factor.

The author would be remiss if she did not recommend adopting Extreme Programming (XP) vs. Scrum Agile practices. XP differs from Scrum in that it incorporates software engineering practices such as test first / test driven development and pair programming in addition to the strictly project management approach that Scrum takes. The introduction and use of software engineering practices included in XP should improve the overall quality of the software.

Clearly there is opportunity for more customer involvement. But just adding more and more customers for one domain (not overlapping domains) may be disruptive and counterproductive. What is needed is more overlapping customer involvement. However, selecting customers that have expertise in multiple technical domains and assigning them to the project is not necessarily up to Agile development teams.

Typically business management assigns staff to work with various software development projects. Therefore, to achieve this overlapping effect, business management must carefully consider the project needs and staff it with uniquely skilled customers. Of the recommendations proposed, this may be the hardest to implement as the engineers and scientists that are needed are typically very busy people and assigning them to software development projects may not be their management's top priority.

Beck and Fowler provide some insightful thoughts about selecting a good customer. [BECK & FOWLER, 2001] A good customer:

- "Understands the domain well by working in that domain, and also by understanding how it works (not always the same thing)
- Can understand, with development's help, how software can provide business value in the domain
- Is determined to deliver value regularly and is not afraid to deliver too little rather than nothing
- Can make decisions about what's needed now and what's needed later
- Is willing to accept ultimate responsibility for the success or failure of the project"

Finally, there is a huge opportunity to have ExxonMobil's internal project management methodologies work for software development projects. The author recommends that both URC's and EMEC's methodologies be revised to include Agile principles and practices for software development projects to the extent that it facilitates project progress and enhances project communication.

8. Future Work

The focus of this case study was on the customer and their impact on the success of Agile software development projects. This information in itself does not contain enough business justification for moving either organization completely towards Agile. Future work should include more comparisons between legacy software development and Agile software development. Such a study is planned internally to ExxonMobil for the first quarter of 2011 and will include more conclusive and potentially compelling reasons to switch all projects to Agile.

The author would have liked to spend more time researching how ExxonMobil Agile developers/testers and customers interact with third party vendors who supply custom components. The choice was made to not include this work as only one project used custom components from third party vendors. However, the interaction between developers/testers and vendors could potentially challenge the success of a project, especially since the vendors are typically not co-located with the development team.

Two of the projects had an additional governance structure in place called a Steering Committee. In both cases, the Steering Committee was comprised of senior development and business management who were charged with making project decisions that affected cost, schedule, and quality. Clearly there is more research needed to see the benefits and impacts of the Steering Committee on the Agile project.

Another side area of interest surrounded the use of user stories. The author found that when customers wrote user stories, the developers/testers had to re-write them so that they would be usable. This common theme from the interviews is worth another look, just for the sake of efficiency.

Last, but not least is the use of manual vs. automated testing for Agile projects. With the rapid pace that Agile requires, it is imperative that both developers/testers and customers automate more tests. Development teams now have tools that enable more automated testing, but customers still seem to lack tools, training, and incentive to move towards that goal. There is definitely a need in this area for improvement and the testing industry is coming out with some interesting solutions. Should ExxonMobil projects move towards more Agile practices, this area should be fully explored.

Appendix

APPENDIX A- DEVELOPER SURVEY AND INTERVIEW QUESTIONS

This appendix is a complete listing of developer/tester survey and interview questions with available responses.

Question	Developer/Tester Interview Questions
DI1	Project name
DI2	Number of end users
DI3	Interviewee names
DI4	Select all interviewees role: • Project Manager • Developer • Tester • Other?
DI5	Indicate the calendar date when your project adopted Agile. What is your iteration length? What triggered you to go to Agile?
DI6	Are you full time on the project? • Yes. • No. If so, indicate the percentage of time you spend on the project
DI7	Describe the team composition • %Developers • % Testers

DI8	How many customers worked with the development team?
DI9	Please provide names of your customer contacts
DI10	What do you believe is the customer's level of participation (percent dedicated time)?
DI11	Were customers primarily: • Co-located with the development team • Close proximity (in the same building) • Located in another office in Houston • In a different time zone
DI12	Which project team member had the most face-to-face time with the customers: • Project manager • Developer • Tester • No one particular person
DI13	Did you have a full time project manager? • Yes • No. If no, indicate the percentage of time the project manager spent on the project
DI14	Were appropriate software development tools in place? • Yes • No. If no, please specify the tools you needed, but did not have.

DI15	What Agile methodology did you use? • Scrum • XP • Other
DI16	What technology area best characterizes your application domain? • Engineering/scientific • Business/productivity • Data extraction, transformation, and loading • Other
DI17	List the technical domains / areas / use cases the application addresses.
DI18	What is your product architecture? • Stand-alone Windows application • Windows client / server • Service oriented architecture • Web application • Other
DI19	What was your primary language? • C++ • C#.NET • VB.NET or ASP.NET • Other
DI20	Did you use a custom 3rd party component in your software? • Yes • No

DI21	Did your project benefit from: • Holding daily Scrum meetings? • Writing user stories (or requirements)? • Maintaining a product backlog? • Prioritizing a product backlog? • Using planning poker for project estimating? • Running sprints? • Performing customer reviews at the end of each iteration? • Performing release planning? • Calculating and using velocity as a means to determine the amount of work that can be accomplished in an iteration? • Calculating and displaying burn down charts? • Having most team members attend a formal Agile training course? • Using test driven or test first development? • Using pair programming? • Creating and executing automated tests? • Performing continuous build and integration? • Performing usability tests? • Performing iteration retrospectives? • Administering customer satisfaction surveys?
DI22	Did your project use a project planning and control (PP&C) methodology? If so, which one?

DI23	Would you say that your PP&C allowed you the flexibility to adopt Agile principles? • Yes • No. If no, why not?
DI24	Please give me the following information. If it is not readily available, please indicate how to best get it: • LOC • % refactoring • Total number of user stories. Indicate if all were implemented. • Was your project behind, on, or ahead of schedule? • Was your project below, on, or over budget? • Number of high and critical severity defects found by the customers post release • Number of test cases. Please break down between manual and automated. • Results of your last usability tests • Results of your last customer survey

Question	Developer/Tester Survey Questions
DS1	What is the application you team works on?
DS2	How many years have you developed or tested applications? • Less than 3 years • 3 - 5 years • 5 - 10 years • More than 10 years
DS3	Have you worked on similar applications in the past? • Yes • No
DS4	Select your area(s) of expertise: • Developing front end / GUIs • Developing back end / simulators • Database development / integration • Testing or quality assurance activities • Writing requirements / user stories • Other (please specify)
DS5	Have you participated on an Agile project in the past? • Yes • No
DS6	At this time, what is the total number of developers and testers on your team?

DS7	Thinking about the members of your team, estimate their level of expertise in developing and testing software. Enter percentages as a whole number. Your answers must sum to 100%. • % experts • % competent • % novice
DS8	Thinking about your Agile team, estimate their level of expertise in Agile principles and practices at the time the project switched to Agile. • % experts in Agile practices • % competent in Agile practices • % novice in Agile practices
DS9	Thinking about your Agile team, estimate their level of expertise in Agile principles and practices at this time. • % experts in Agile practices • % competent in Agile practices • % novice in Agile practices
DS10	Indicate your level of agreement with these statements. Note: answers were given in a 5-point Likert scale of Agree Strongly, Agree, Neither Agree nor Disagree, Disagree, and Disagree Strongly. • Our team exhibited a collaborative attitude • Each team member showed a sense of responsibility for completing his / her tasks • Team members were eager to learn and try new things

DS11	Would you consider your Agile project successful? • Yes • No • Maybe, with qualifications (please specify)
DS12	Select three measures of project success that are important to you and rank them in order of importance (i.e. 1 = most important, 2 = second most important, 3 = third most important). • The project was on (or ahead of schedule) • The project was on (or under) budget • We were able to completely implement all features • We met customer's expectations • The customers found no critical or high severity defects in production software • Testing covered most features • The product was fit for purpose • The project was fun to work on

DS13	Select the top three factors that you think contributed to the project's success and rank them in order of importance (i.e. 1 = most important, 2 = second most important, 3 = third most important). • We had competent and dedicated developers and testers on our team • We had access to active and knowledgeable customers • We used Agile project management principles • We used appropriate software development and testing tools • Our Agile team was co-located • We had limited changes to requirements • We held frequent meetings and communication between team members • Our supervisor and mangers were supportive • We had a dedicated project manager • Most of the team attended Agile training

APPENDIX B – CUSTOMER SURVEY AND INTERVIEW QUESTIONS

This appendix is a complete listing of customer survey and interview questions with available responses. Note: these preliminary remarks were given to customers at the first of their interview:

- I've conducted interviews with the development team prior to this interview
- They gave me some basic information about this project
- If you disagree with their information, that is OK. Just provide corrections.

Question	Customer Interview Questions
CI1	Project name
CI2	Interviewee names
CI3	The developers / testers gave me this time frame for this interview. Do you agree to hold your responses to this time?
CI4	Are you full time on the project? • Yes. • No. If so, indicate the percentage of time you spend on the project
CI5	Of the time you spend on the project, indicate the time: • You worked jointly with a member of the development team • You worked independently

CI6	Were you primarily: • Co-located with the development team • Close proximity (in the same building) • Located in another office in Houston • In a different time zone
CI7	On average, how often did you have informal, face-to-face meetings with the development team for any reason? • Daily • 2 -3 times per week • Once a week • Once every two weeks • Once a month • Longer than once a month
CI8	On average, how often did you have formal, scheduled meetings with the development team for any reason? • Daily • 2 -3 times per week • Once a week • Once every two weeks • Once a month • Longer than once a month

CI9	Which project team member did you have the most face-to-face time with? • Project manager • Developer • Tester • No one particular person
CI10	Are you familiar with Agile software development practices? • Never heard of it • Heard of it, but didn't realize that was what the development team was doing • Read about it and asked the developers a few questions • Took training as an Agile customer so that I could apply those principles to my role on this project
CI11	The developers listed these technical domains / areas / use cases for application. Do you agree? Are there others?

CI12	Did you participate in any of these activities? If so, indicate the primary way you engaged with the development team to transfer knowledge (phone, email, instant messaging, documentation such as a research paper, group meeting, face-to-face meeting): • Holding daily Scrum meetings? • Writing user stories (or requirements)? • Maintaining a product backlog? • Prioritizing a product backlog? • Using planning poker for project estimating? • Running sprints? • Performing customer reviews at the end of each iteration? • Performing release planning? • Calculating and using velocity as a means to determine the amount of work that can be accomplished in an iteration? • Calculating and displaying burn down charts? • Having most team members attend a formal Agile training course? • Using test driven or test first development? • Using pair programming? • Creating and executing automated tests? • Performing continuous build and integration? • Performing usability tests? • Performing iteration retrospectives? • Administering customer satisfaction surveys?

Question	Customer Survey Questions
CS1	How many years have you worked in the oil and gas industry? • Less than 3 years • 3 - 5 years • 5 - 10 years • More than 10 years
CS2	What is you level of education? • Non-degreed • Associate (2 year) degree • Bachelor's degree • Master's degree • PhD
CS3	Have you worked on software development projects in the past? • Yes • No
CS4	Select your primary area(s) of expertise. Note: each customer would chose from a list of areas given by the development team and the customer interview.
CS5	For the technical areas below, were you asked to represent users in this area? Note: each customer would select "yes" or "no" from a list of areas given by the development team and the customer interview.

CS6	For the technical areas below, please select your level of expertise. Note: each customer would select one of the following responses "basic", "competent", "expert" or "advanced expert" from a list of areas given by the development team and the customer interview.
CS7	Do you believe you transferred your technical knowledge proactively (via training or mentoring) or reactively (only when requested)? • Proactively, via mentoring or training • Reactively, only when requested • As appropriate
CS8	For this project, did you have all the tools you needed to do your job? Note: tools may be email, networks, databases, Intra / Internet. • Yes • No. If no, please specify the tools you needed, but did not have.
CS9	When given a choice, how do you prefer to communicate with the development team? • In person • Phone • Email • Instant Message

CS10	For this project, did you have a common set of procedures to do your job? Note: procedures may be things defined by your project management methodology like a defined set of project documents or approval and gating requirements. • Yes • No • Don't know
CS11	In your opinion, did these procedures help project progress or hinder it? • Helped project progress • Hindered project progress • No opinion
CS12	In your opinion, did these procedures enhance communication or confuse it? • Enhanced communication • Confused communication • No opinion
CS13	Did you management encourage you to make yourself available to the project team? • Yes • No • Somewhat (please qualify)

CS14	Typically in a software development project the developers ask customers to make project decisions. Those decision might include: (1) determining what is in scope or out of scope, (2) prioritizing work items, (3) verifying that calculations /algorithms are correct, (4) finding and reporting product defects, (5) reviewing and accepting a product or (5) approving the product is ready for release. Did the development team ask you to make project decisions? • Yes • No
CS15	On average, how many project decisions did you make per week? • I did not make decisions • 1 - 5 decisions per week • 6 - 10 decisions per week • Greater than 10 decisions per week
CS16	Select the statement that best describes how empowered you felt when making project decisions: • I did not make decisions, I waited to be told what to do. • I made very few decisions. I mostly provided recommendations. • I made some decisions; however, I usually had to ask for additional instructions. • I made decisions, but only when prompted by the development team. • I made a number of decisions, some without prompting, and reported them to the development team.

CS17	Indicate your level of agreement with these statements. Note: answers were given in a 5-point Likert scale of Agree Strongly, Agree, Neither Agree nor Disagree, Disagree, and Disagree Strongly. • The development team exhibited a collaborative attitude • Each development team member showed a sense of responsibility for completing his / her tasks • Development team members were eager to learn and try new things
CS18	Would you consider your Agile project successful? • Yes • No • Maybe, with qualifications (please specify)
CS19	Select three measures of project success that are important to you and rank them in order of importance (i.e. 1 = most important, 2 = second most important, 3 = third most important). • The project was on (or ahead of schedule) • The project was on (or under) budget • The development team were able to completely implement all features • The software met my expectations • We found no critical or high severity defects in production software • Testing covered most features • The product was fit for purpose • The project was fun to work on

CS20	Select the top three factors that you think contributed to the project's success and rank them in order of importance (i.e. 1 = most important, 2 = second most important, 3 = third most important). • We had competent and dedicated developers and testers on the project • Customers were active and knowledgeable customers • The project used Agile project management principles • The project used appropriate software development and testing tools • Our offices were closely located to the development team • We did not change our requirements often • We had frequent meetings and communication with the development team • Our supervisor and mangers were supportive of us spending time on the project • The project had a dedicated project manager • Most of the customers attended Agile training

APPENDIX C – TRANSFORMING ORDINAL AND NOMINAL ANSWERS TO AN INTERVAL (5-POINT) SCALE

The following tables indicated values were assigned to relevant questions with ordinal and nominal answers. For a full listing of the questions, see Appendix A (developer interview and survey questions) and Appendix B (customer interview and survey questions).

Developer/Tester Interview

Question DI11	Answers	Points	Rationale
Were customers primarily:	Co-located with the development team	5	Co-location enhances effective and efficient knowledge transfer and thus received the highest number of points. Other points decreased as the customer moved further away from the development team.
	Close proximity (in the same building)	4	
	Located in another office in Houston	3	
	In a different time zone	2	

Question DI14	Answers	Points	Rationale
Were appropriate software development tools in place?	Yes	5	The presence of tools to perform work enhances efficient knowledge transfer and thus received the highest number of points. Note that these are developer tools such as Microsoft Visual Studio© and Team Foundation Server©.
	No	4	

Developer/tester Survey

Question DS2	Answers	Points	Rationale
How many years have you developed or tested applications?	More than 10 years	5	More experienced developers or testers increase the chances of having a product that customers value thus the higher number of points. Points decreased as the number of years experience decreased.
	5 - 10 years	4	
	3 - 5 years	3	
	Less than 3 years	2	

Question DS3	Answers	Points	Rationale
Have you worked on similar applications in the past?	Yes	5	Working on similar applications in the past increases the chances of having a product that customers value thus the higher number of points.
	No	4	

Question DS11	Answers	Points	Rationale
Would you consider your Agile project successful?	Yes	4	Successful projects command more points than non-successful projects. Note that this is the developer's response (and not the customer's). Since the developer is not the last word in declaring success, they get 4 points for successful project as compared to customer's getting 5 points for a successful project. To get a comprehensive picture of success, combine the developer's and customer's perception of success.
	No	1	
	Maybe, with qualifications	2	

Customer Survey

Question CS1	Answers	Points	Rationale
How many years have you worked in the oil and gas industry?	More than 10 years	5	More experienced customers theoretically have more experience and thus given a higher number of points. Points decreased as the number of years experience decreased.
	5 - 10 years	4	
	3 - 5 years	3	
	Less than 3 years	2	

Question CS2	Answers	Points	Rationale
What is you level of education?	PhD	5	More educated customers theoretically have more knowledge and thus given a higher number of points. Points decreased as the level of education decreased
	Master's degree	4	
	Bachelor's degree	3	
	Associate (2 year) degree	2	
	Non-degreed	1	

Question CS3	Answers	Points	Rationale
Have you worked on software development projects in the past?	Yes	5	Working on software development projects in the past gives customers some experience working with a development team, thus the higher number of points.
	No	3	

Question CS6	Answers	Points	Rationale
For the technical areas below, please select your level of expertise.	Advanced Expert	5	More competent customers theoretically have more experience and thus given a higher number of points. Points decreased as the level of competency decreased.
	Expert	4	
	Competent	3	
	Basic	2	

Question CS7	Answers	Points	Rationale
Do you believe you transferred your technical knowledge proactively (via training or mentoring) or reactively (only when requested)?	Proactively, via mentoring or training	5	Proactive customer training or mentoring is essential for effective and efficient knowledge transfer and thus the higher points. As appropriate was viewed as a neutral answer. Reactive customers who only transferred knowledge when requested were given a low number of points.
	As appropriate	3	
	Reactively, only when requested	1	

Question CS8	Answers	Points	Rationale
For this project, did you have all the tools you needed to do your job? Note: tools may be email, networks, databases, Intra / Internet.	Yes	5	The presence of tools to supply information enhances efficient knowledge transfer and thus received the highest number of points. Note that these are customer tools, and should not be confused with developer tools.
	No	3	

Question CS9	Answers	Points	Rationale
When given a choice, how do you prefer to communicate with the development team?	In person	**5**	Based on Scott Ambler's figure, face-to-face communication is the most efficient and effective means of transferring knowledge and thus received the highest number of points. As communication methods became less personal or abbreviated, the points were decreased.
	Phone	**4**	
	Email	**3**	
	Instant Message	**2**	

Question CS10	Answers	Points	Rationale
For this project, did you have a common set of procedures to do your job? Note: procedures may be things defined by your project management methodology like a defined set of project documents or approval and gating requirements	Yes	5	A common set of procedures is essential for project success. They also enhance the efficiency and effectiveness of knowledge transfer and thus received a higher number of points. An answer of "no" produced the lowest number of points, and "don't know" was perceived as a neutral answer.
	Don't Know	3	
	No	1	

Question CS11	Answers	Points	Rationale
In your opinion, did these procedures help project progress or hinder it?	Helped project progress	5	Procedures that help project progress enhance the efficiency of knowledge transfer and thus received a higher number of points. An answer of "hindered project progress" produced the lowest number of points, and "no opinion" was perceived as a neutral answer.
	No opinion	3	
	Hindered project progress	1	

Question CS12	Answers	Points	Rationale
In your opinion, did these procedures enhance communication or confuse it?	Enhanced communication	5	Procedures that help project communication enhance the effectiveness of knowledge transfer and thus received a higher number of points. An answer of "confused communication" produced the lowest number of points, and "no opinion" was perceived as a neutral answer.
	No opinion	3	
	Confused communication	1	

Question CS13	Answers	Points	Rationale
Did you management encourage you to make yourself available to the project team?	Yes	5	Management support is essential to allow customers to be committed to projects. An answer of "yes" received the highest number of points. An answer of "no" received the lowest number of points. "Somewhat" was better than "no" and thus received more points.
	Somewhat	3	
	No	1	

Question CS15	Answers	Points	Rationale
On average, how many project decisions did you make per week?	Greater than 10 decisions per week	5	Customers that were empowered to make a number of decisions were given a higher number of points. Point totals decreased as customers made fewer decisions.
	6 - 10 decisions per week	4	
	1 - 5 decisions per week	3	
	I did not make decisions	2	

Question CS16	Answers	Points	Rationale
Select the statement that best describes how empowered you felt when making project decisions:	I made a number of decisions, some without prompting, and reported them to the development team	5	Empowered customers make a number of independent decisions and thus received a higher number of points. Points decreased as the level of customer empowerment decreased.
	I made decisions, but only when prompted by the development team.	4	
	I made some decisions; however, I usually had to ask for additional instructions	3	
	I made very few decisions. I mostly provided recommendations	2	
	I did not make decisions; I waited to be told what to do.	1	

Question CS18	Answers	Points	Rationale
Would you consider your Agile project successful?	Yes	5	Successful projects command more points than non-successful projects. Note that this is the customer's response (and not the developer's) and should command more points than the developer's. To get a comprehensive picture of success, combine the developer's and customer's perception of success.
	Maybe, with qualifications	3	
	No	1	

References

[1] Poppendieck, T. *The Agile Customer's Toolkit*. Copyright 2003, Poppendieck LLC. http://www.torak.com/site/files/The%20Agile%20Customer%E2%80%99s%20Toolkit.pdf

[2] Mar, K. *A Generalized Framework for Agile Roles and Responsibilities*. Blog entry December 21, 2005. http://kanemar.com/2005/12/21/a-generalized-framework-for-agile-roles-and-responsibilities/

[3] Poppendieck, T. *The Customer Role in Agile Projects*. A workshop at OOPSLA 2004. http://www.poppendieck.com/agilecustomer_workshop.htm

[4] Farell, C., Narang, R., Kaptian, S., Webber, H. *Towards and Effective Onsite Customer Practice*. A joint paper from Intelliware Development, Inc. and Celidon Inc. Toronto, Ontario. 2002

[5] Highsmith, Jim. *History: The Agile Manifesto*. The Agile Alliance, 2001. http://agilemanifesto.org/history.html

[6] Hanssen, G. and Faegri, T. *Agile Customer Engagement: A Longitudinal Qualitative Case Study*. ISESE'06, September 21-22, Rio de Janerio, Brazil. 2006.

[7] Boehn, B. *Get Ready for Agile Methods, with Care*. IEEE, January 2002.

[8] Ambler, S. *Disciplined Agile Software Development: Definition*. Agile Modeling. http://www.agilemodeling.com/essays/agileSoftwareDevelopment.htm, 2005 – 2010.

[9] Coram, M. and Bohner, S. *The Impact of Agile Methods on Software Project Management*. 12th IEEE International Conference and Workshops on the Engineering of Computer-Based Systems (ECBS'05), 2005.

[10] Grisham, P. and Perry, D. *Customer Relationships and Extreme Programming*. ACM SIGSOFT Software Engineering Notes, 2005.

[11] Krasner, H. *Agile Software Measurement course notes*. Software System Measurement and Metrics -- EE382V(#77293), Summer semester 2010.

[12] NBA Roland Ratings http://www.82games.com/rolandratings2.htm. Copyright © 2003 by 82games.com.

[13] Karlsen, J. and Gottschalk, P. *Factors Affecting Knowledge Transfer in IT Projects*. Engineering Management Journal, Mar 2004. http://findarticles.com/p/articles/mi_qa5394/is_200403/ai_n21347647/

[14] Covey, F. *The Seven Levels of Initiative or Self Empowerment*. From the book The 8th Habit. 2004. http://jawadhabib.org/blog/index.php/2010/03/7-levels-of-initiative/

[15] Laframboise, K., Croteau, A., Beaudry, A., and Manovas, M. *Interdepartmental knowledge transfer success during information technology projects*. International Journal of Knowledge Management. 2007.

[16] Walz, D., Elam, J., Curtis, B. *Inside a Software Design Team: Knowledge Acquisition, Sharing and Integration*. Communication of the ACM. October, 1993. Vol. 36, No. 10.

[17] Curtis, B., Krasner, H., and Iscoe, N. *A field study of the software design process for large systems.* Communication of the ACM. 1988. Vol. 31, No. 11.

[18] Turner, R. and Boehm, B. *People Factors in Software Management: Lessons From Comparing Agile and Plan-Driven Methods*. CrossTalk: The Journal of Defense Software Engineering. December 2003.

[19] Ambler, S. *Communication on Agile Software Projects*. Ambysoft 2001 – 2009. http://www.agilemodeling.com/essays/communication.htm

[20] Beck, K. et. al. *The Agile Manifesto*. http://agilemanifesto.org/ Copyright 2001.

[21] Krasner, H. *GQM Oriented Measurement course notes*. Software System Measurement and Metrics -- EE382V(#77293), Summer semester 2010.

[22] Mulkay, E. and Baker, D., *Meeting Complex Drilling and Subsurface Challenges Through Advanced Software Tools*. A paper presented at the International Petroleum Technology Conference, Doha, Qatar, December 2009.

[23] Princton University. WordNet 3.0 Search for the Definition of Efficient. 2010. http://wordnetweb.princeton.edu/perl/webwn?s=efficient

[24] Beck, K. and Fowler, M. *Planning Extreme Programming*. Addison Wesley, 2001.

Vita

Susan Ragaz Brockley was born in North Carolina and went to the University of Tennessee where she obtained two degrees: a Bachelor of Arts in Mathematics (1977) and a Master of Science in Civil Engineering (1980). This, of course, was accomplished between Tennessee football games where she sang Rocky Top with all the other big orange fans.

Eager to take on the world, she moved to Houston TX upon being hired by Brown&Root as a structural engineer. Through a series of career moves she became very interested in software engineering in the early 1980's and the rest is history.

After ten years with Brown&Root, Ms. Brockley was hired by Exxon Production Research Company (now ExxonMobil Upstream Research) and has worked for twenty years in the areas of project management, testing, and quality assurance.

The passion for obtaining software engineering credentials enticed her to begin a Software Engineering Master's degree. Her hope is that she can use this degree to teach and inspire others, whether in the corporate world or in academia.

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